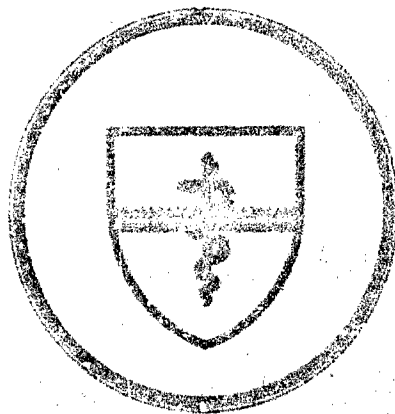


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NAVAL SUBMARINE MEDICAL
RESEARCH LABORATORY
SUBMARINE BASE, GROTON, CONN.



REPORT NUMBER 1006

EFFECTIVENESS OF THE MARK V CHEMICAL-BIOLOGICAL
MASK WORN OVER SPECTACLES

by

S. M. Luria and J. H. Dougherty, Jr.

Naval Medical Research and Development Command
Research Work Unit MC100.901-1020

Released by:

William C. Milroy, CAPT, MC, USN
COMMANDING OFFICER
Naval Submarine Medical Research Laboratory

6 July 1963

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SUMMARY PAGE

PROBLEM:

To measure the leakage into the Mark V Chemical-Biological Mask when worn over eyeglasses.

FINDINGS:

There were appreciable leaks into the Mark V mask with all spectacle frames tested, although the magnitude of leakage varied greatly with different frames. As expected, bearded men suffered more leaks than clean-shaven men.

APPLICATION:

These findings indicate that the Mark V mask can not satisfactorily be worn over eyeglasses. Since nearly 50% of the young men entering the Navy now need some refractive correction, the inability to wear glasses under the mask means that the visual acuity of some men will be too poor to allow them to carry out their duties while wearing the mask. The mask must either be designed to permit space for eyeglasses, or spectacle inserts must be designed to fit into the present mask.

ADMINISTRATIVE INFORMATION

This research was conducted under Naval Medical Research and Development Command Work Unit M0100.001-1020 - "Correcting vision in emergency breathing masks." It was submitted for review on 30 June 1983, approved for publication on 6 July 1983, and designated as NavSubMedRschLab Rep. No. 1006.

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ABSTRACT

Leakage into the Mark V Chemical-Biological Mask was measured when it was worn over four different eyeglass frames, the Standard S-10 Navy issue, the Sampson P-3 gold wire and P-3 matte chrome frames, and the Army combat frame. Although there were great differences between frames, there was appreciable leakage with every frame.

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If the atmosphere in a submarine becomes contaminated, the crew members must wear emergency masks. Three kinds of masks are available. The Emergency Air Breathing Mask (EAB) provides uncontaminated air from storage tanks, but restricts the movement of the wearer to the distance which his air hose will reach. The Oxygen Breathing Apparatus (OBA) provides oxygen from tanks carried on the chest. The Mark V Chemical-Biological Mask, on the other hand, has cannisters which filter the contaminated air (Fig. 1). When effective, this mask is preferable since it is lightweight and movement is not restricted.

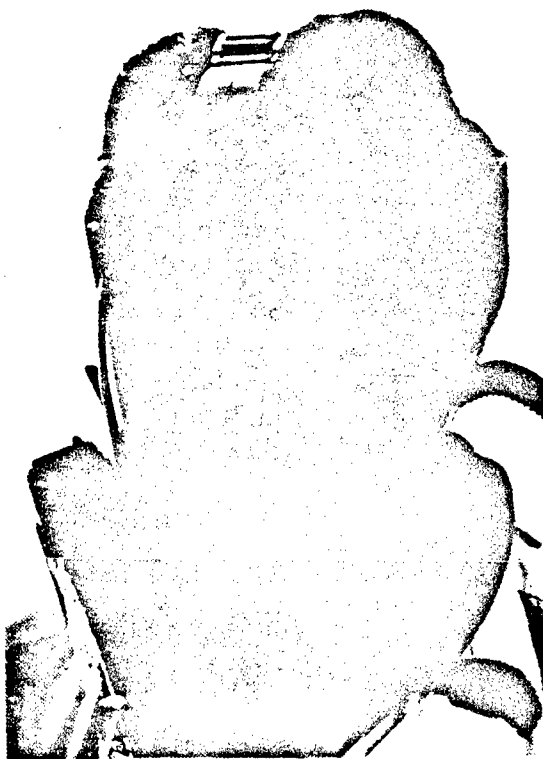


Fig. 1. The Mark V Chemical-Biological Mask. Contaminated air is filtered through the two cannisters.

Whichever mask the submariner wears, he may have problems achieving a satisfactory seal around his head if he is also wearing eyeglasses. Since nearly 50% of submariners wear glasses,^{1,2} the chances of such a problem arising are substantial. The crewman thus has the choice of taking his glasses off before putting on the mask and then suffering from poor visual acuity as he tries to carry out his duties or leaving his glasses on under the mask and risking leakage of the contaminated air into the mask. This is an unpleasant choice since many tasks on a submarine require 20/20 vision and eyeglasses are essential for many men.³ Moreover, visual defects have been increasing during the last generation, and the problem may get worse.² The EAB was evaluated in a previous study,⁴ and appreciable differences in leaks were found with different spectacle frames.

In this investigation we measured the amount of leakage into the Mark V mask when it was worn over four different eyeglass frames and also had subjects evaluate the comfort of the mask under these conditions.

METHOD

The Spectacle Frames

The amount of leakage into the mask was measured with the subjects wearing either one of four different spectacle frames or no frames. The frames were the standard S-10 Navy issue, the Sampson P-3 gold wire frame, the P-3 matte chrome wire frame, and the U.S. Army combat frame (Fig. 2).

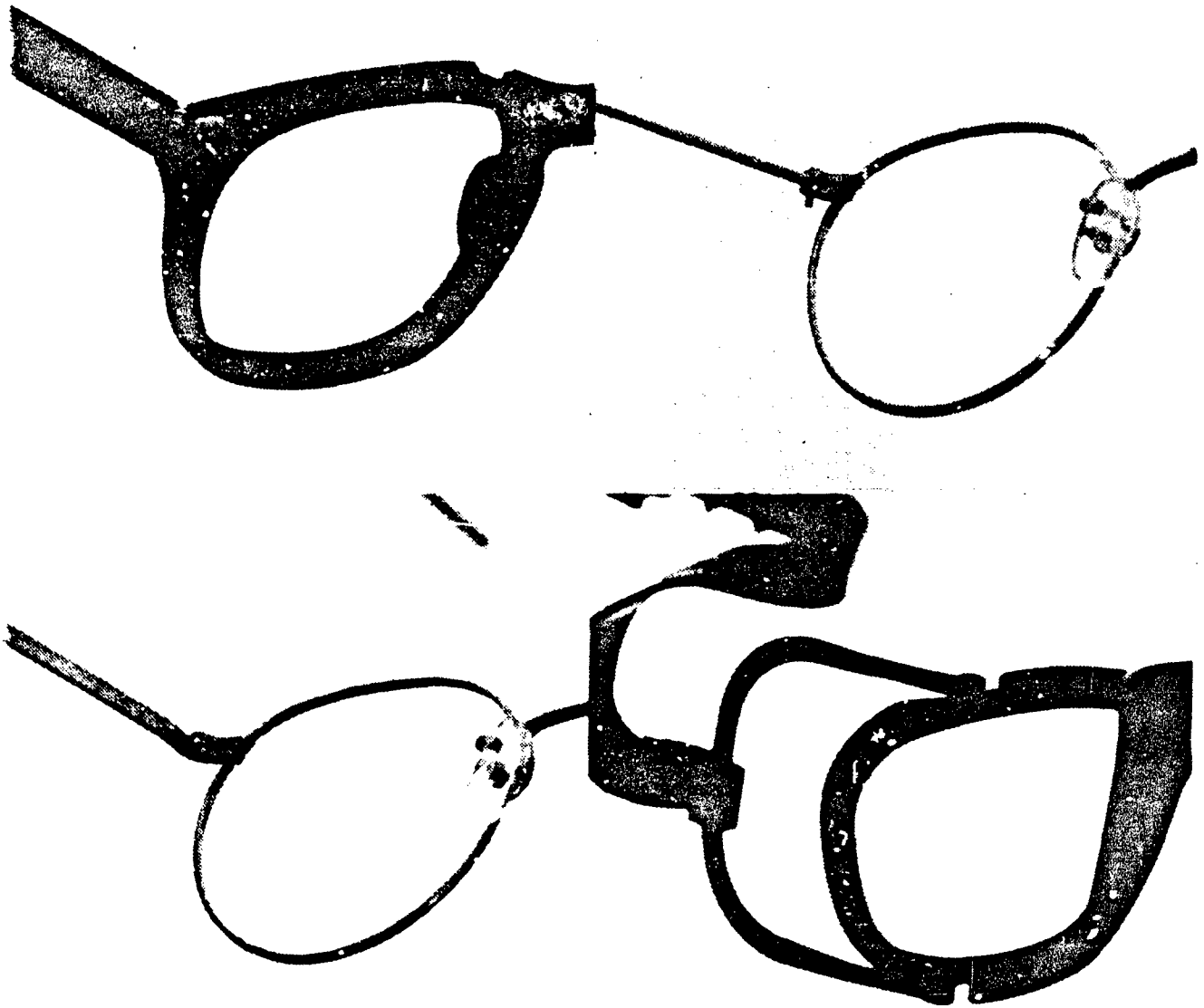


Fig. 2. The Navy standard issue S-10 spectacle frame (upper left), the Sampson P-3 gold wire frame (upper right), the Sampson P-3 matte Chrome frame (lower left), and the Army combat frame (lower right).

Procedure

The subjects put the mask on themselves and adjusted the fit to their own satisfaction. To measure leakage into the mask, it was worn under a plastic hood which was designed to test mask-leakage and which allowed the cannisters on the mask to be exposed to the room air (Fig.3), while a different mixture surrounded the mask itself. This



Fig.3. Leakage into the mask was determined by bleeding helium into the space between the plastic hood and the mask. The hood covers the mask, but the cannisters of the mask are exposed to room air.

mixture, 4% helium in air (21% oxy-

gen, 74% nitrogen, 4% helium, and 1% argon), was continuously bled into the small space between the hood and the mask. Helium was used as the marker gas because of its relatively high diffusion through materials and because its atomic weight and mass are similar to that of tritium, the radioactive contaminant of principal concern aboard submarines.

Two probes, one inside the mask and one inside the hood, sampled the air (Fig. 4). The amount of helium in both air spaces was then measured with a Scientific Research Instruments (G. D. Searle) medical mass spectrometer. Readings were taken every minute, and the run was terminated when they had been stable for 5 minutes. In no case was a run continued for more than 15 minutes. A reading of 4% indicated the maximum concentration of helium; such a reading inside the mask would indicate 100% leakage--a complete lack of seal and no protection at all. A reading of zero inside the mask would, of course, indicate a perfect seal (0% leakage).

At the end of each run the subject was given a brief rest, after which a new pair of frames was put on, the mask and hood put on, and another run carried out. Each subject wore the various frames in a different and counterbalanced order.

Subjects

Eight men, four clean-shaven and four bearded, volunteered to serve as subjects. All were members of the laboratory staff and gave their informed consent. The study was approved by the Committee for the Protection of Human Subjects at the Laboratory.



Fig. 4. The presence of helium was detected inside the hood by one probe and inside the mask by the second probe.

RESULTS

Table I gives the amounts of leakage into the mask when it was worn over the various frames. The figures are the ratio of the percent helium detected inside the mask to the percent of helium detected inside the hood. Thus, if there was 4.0% helium inside the hood and 1.0% inside the mask, the magnitude of leakage would be 25%. *

 * The results are given as this ratio, because the percentage of helium in the hood could not always be maintained at exactly 4% owing to leakage around the neck.

Table I shows that there are very great differences in the effectiveness of the mask when worn over different frames. Furthermore, bearded men will, on the average, suffer greater leakage than clean-shaven men.

When wearing no eyeglasses, the mean percentage of leakage was 1.81% for the clean-shaven subjects and 8.17% for the bearded ones. With the Standard S-10 Navy issue frame, no subject could achieve anything approaching a seal. Every subject showed 100% leakage when wearing those frames. The P-3 frames resulted in about 9 to 11% leakage, with slightly more leakage on the average for the matte chrome frame than the gold wire one. The Army

TABLE I. Percentage of helium leakage into the Mark V mask worn over various spectacle frames by clean-shaven and bearded men

S	No Frames	Standard S-10 Navy Issue	Sampson P-3 Gold Wire	Sampson P-3 Matte Chrome	Combat Frame
CLEAN-SHAVEN					
JB	1.30	100.00	2.60	11.76	1.34
JW	5.95	100.00	3.70	6.59	2.47
RR	0.00	100.00	13.33	7.14	46.38
DN	0.00	100.00	2.25	1.12	2.27
Mean	1.81	100.00	5.47	6.65	13.12
BEARDED					
DK	1.18	100.00	4.76	3.61	3.70
TS	4.82	100.00	8.00	30.56	14.94
WR	14.47	100.00	20.51	14.10	8.97
KB	12.20	100.00	15.00	13.58	72.60
Mean	8.17	100.00	12.07	15.46	25.05
Grand Mean	4.99	100.00	8.77	11.05	19.08

combat frame resulted in about 20% leakage.

The subjects also rated the frames for comfort. There is some relationship between these ratings and the amount of leakage. In order to try to obtain a seal, it was necessary to force the frames against the nose and face. When the frames were too large for the mask, this became very

uncomfortable. The standard Navy issue S-10 was judged to be the most painful to wear, and many of the subjects said they would not wear them under the mask even in an emergency. The combat frames were only slightly more comfortable, although most of the subjects could have tolerated it for a short time. There was no agreement between the subjects about the P-3 frames. One

man rated them as comfortable under the mask and two rated them as only slightly uncomfortable, but two men said they were extremely painful. Such differences were clearly attributable to the variation in the shape of their heads and noses.

DISCUSSION

As was found in the evaluation of the EAB,⁴ (a) the Mark V mask did not provide a perfect seal under any condition, (b) there were great differences in its effectiveness when worn over different eyeglass frames, and (c) bearded men will suffer greater leakage, on the average, than clean-shaven men.

The ranges of leakage for the two groups of men, however, show what became quite clear during the study: the effectiveness of the seal obtained with the Mark V depends mostly on the shape of the head and the configuration of the bridge of the nose and the brows. This is particularly so when wearing eyeglasses. Table I shows that there was more leakage with the matte chrome P-3 frames than with the gold wire P-3. Although it is true that the temples of the former are larger, it seems clear that the greater leakage was due primarily to a slight difference in the configuration of the nose-guards; the subjects complained of more pressure on the bridge of the nose when wearing the gold-wire frame. This in turn produced differences in the distance of the frames from the face, changed the distance of the mask from the face, and affected the tightness of the seal.

With the standard S-10 Navy issue frame, no subject could achieve

anything approaching a seal. The Mark V mask allows virtually no room at all for the large eyeglass frames which are now common. Every subject suffered 100% leakage when wearing those frames.

The Army combat frames, which have also been called "mask compatible" frames, did not fare well with the Mark V mask; the name is clearly premature. The combat frame produced greater leaks than did either of the P-3 frames. The reason is solely that the frame of the eyeglass is larger than that of the P-3. The lens in the P-3 is relatively small, but the lens in the combat frame is identical in size and shape to that in the standard S-10. Its larger size prevented the Mark V from sealing against the forehead.

These results are in contrast to those obtained with the EAB.⁴ With the much larger EAB, the combat frames did not interfere with the seal, and the amount of leakage was the same as with no frames at all. With the Mark V mask, the amount of leakage is similar to that found with the S-10 worn with the EAB--about 20%--an unacceptable amount of leakage.

Apparently, the Mark V mask was not designed to be worn over eyeglasses. Few individuals will find the mask tolerable over glasses for any length of time, and then only with glasses with small frames and lens-holders. The smallest mean leakage for clean-shaven men wearing glasses was about 5%. The question arises therefore whether or not there will be a leakage level low enough to be safe with any pair of glasses.

Moreover, these results were obtained with men sitting quietly

in a controlled situation. If they were required to engage in any activity, the leakage would presumably be even greater. Since the advantage of the Mark V is that it allows unrestricted movement, additional leakage while moving would be particularly unwelcome.

ACKNOWLEDGMENT

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